SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, WATARU NARA, a citizen of Japan residing at Kanagawa, Japan have invented certain new and useful improvements in

IMAGE READING APPARATUS

of which the following is a specification:-

1   BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image

reading apparatus which uses a photoelectric device

5   such as a charge-coupled device (CCD) or the like, and

generates an image signal from an original image, and,

in particular, to an image reading apparatus which

performs correction, using data of a black reference

level, on image data obtained from the original image

10   through the photoelectric device.

2. Description of the Related Art

An image reading apparatus in the related

art, which apparatus uses a photoelectric device such

15   as a charge-coupled device (CCD) or the like, and

generates an electric image signal from an original

image, performs a correction, using data of a black

reference level, on image data obtained from the

original image through the photoelectric device. The

20   method thereof will now be described.

Generally speaking, an image signal

outputted from a CCD includes a signal component due

to a dark current which does not change due to change

in an amount of light received by the CCD, and a

25   signal component which changes in accordance with the

1   change in the amount of light received by the CCD.   A

     signal component which is effective for image

     processing is only the signal component which changes

     in accordance with the change in the amount of light

5   received by the CCD.   Accordingly, in order to obtain

     the signal component which is to be outputted to a

     following image processing circuit, it is necessary to

     perform the correction (black shading correction) to

     subtract the data of the signal component due to the

10   dark current from the data of the image signal

     outputted from the CCD.

          The signal component due to the dark current

     can be obtained as a result of outputs of an optical

     black (OPB) portion provided as part of a line of

15   photoelectric sensors of the CCD (scan beginning part

     in a main scan direction, as shown in FIG. 1) being

     averaged, before the CCD reads the original image, for

     each line, for example.   The OPB portion provided as

     the part of the line of the photoelectric sensors of

20   the CCD is obtained as follows: Aluminum deposition

     is performed on several (for example, eight, sixteen,

     or the like) photoelectric sensors of the line of the

     (for example, thousands of) photoelectric sensors of

     the CCD, each photoelectric sensor corresponding to a

25   pixel, which several photoelectric sensors are

1   arranged at the end at which scanning in the main scan

direction begins. Thereby, these several

photoelectric sensors of the CCD are covered by the

aluminum film, and, as a result, are shielded from

5   light, and, thus, no light is received by these

several photoelectric sensors of the CCD. Thereby,

the data of the black reference level can be obtained

using the data obtained from the several photoelectric

sensors of the OPB portion of the CCD.

10   FIG. 2 is a block diagram showing essential

portions of one example of an image reading apparatus

including a black shading correction portion for

performing the above-mentioned correction (black

shading correction) in the related art.

15   The image reading apparatus shown in FIG. 2

includes a CCD portion 1 which comprises a CCD

including a line of photoelectric sensors extending in

the main scan direction, and generates an image signal

from an original image as a result of reading the

20   original image. The reading of the original image is

performed as follows: The CCD portion 1 scans a first

line of the original image in the main scan direction

along the line of the photoelectric sensors of the CCD

(whereby image data of the first line is obtained) and

25   scans the original image in the sub-scan direction

1   (perpendicular to the main scan direction) by

     sequentially scanning subsequent lines of the original

     image (whereby image data of respective lines, i.e., a

     second line, a third line, ..., an n-th line, is

5   obtained in sequence). The CCD of the CCD portion 1

     is the same as the above-described CCD having the OPB

     portion. The image reading apparatus further includes

     a signal processing portion 2 which performs

     processing of an analog image signal outputted from

10   the CCD portion 1, an A-D converting portion 3 which

     is an A-D converter converting the analog image signal

     into a digital image signal, a peak hold (P/H) portion

     4 for detecting a background level of the original

     image, a black shading correction portion 5 which

15   performs the correction, using the data of the black

     reference level, on the image signal, and a white

     shading correction portion 6 which performs white

     shading correction on the image signal. Further, the

     black shading correction portion 5 includes an

20   average-value calculating circuit 7 which calculates

     the average of the outputs of the CCD portion 1 during

     the period during which the CCD portion 1 obtains data

     (to be used for obtaining the black reference level)

     through the photoelectric sensors of the above-

25   mentioned OPB portion of the CCD, and a subtracter 8

1   which subtracts the average calculated by the average-

value calculating circuit from the data of the image

signal obtained from the original image.

In FIG. 2, the image analog signal outputted

5   by the CCD portion 1 undergoes signal processing

through the signal processing portion 2, and, then, is

converted into the digital image signal by the A-D

converting portion 3. The digital image signal

outputted from the A-D converting portion 3 is

10   inputted to the black shading correction portion 5,

undergoes the black shading correction therethrough,

and, then, is outputted. The image signal outputted

from the black shading correction portion 5 is

inputted to the white shading correction portion 6.

15   The white shading correction portion 6 performs the

white shading correction on the data of the thus-

inputted image signal using white reference data which

was obtained using a white reference plate or the

like. Then, the image signal is inputted to an image

20   processing block (not shown in the figure).

In the black shading correction portion 5,

the average calculating circuit 7 calculates the

average of the outputs from the OPB portion in the CCD

portion 1 as the data of the reference black level at

25   the beginning of reading of an original image for each

1   line, and outputs the thus-calculated average Dopb

(the average of the pixel values (of the OPB portion)

in the main scan direction). The subtracter 8, which

has received the average Dopb, subtracts the average

5   Dopb from the data DO of the image signal (outputted

from the A-D converting portion 3 when the original

image is read), and outputs the thus-obtained data to

the white shading correction portion 6. Thus, the

black shading correction portion 5 averages the data

10   outputted from the OPB portion of the CCD portion 1

for each line, and, thereby, obtains the data of the

black reference level to be used for the black shading

correction to eliminate the black offset from the

image signal. The calculation of the average

15   performed by the average calculating circuit 7 is

performed only during the period during which the

average calculating circuit receives an OPBGATE

signal, which is provided to the average calculating

circuit 7 only during the period during which data

20   obtained from the OPB portion in the CCD portion 1 is

outputted from the CCD portion 1.

As shown in FIG. 2, the peak hold (P/H)

portion 4 is connected between the signal processing

portion 2 and the A-D converting portion 3. The peak

25   hold portion 4 holds the peak value of the output from

1   the signal processing portion 2, and provides the peak

value to the A-D converting portion 3 as the reference

voltage of the A-D converting portion 3. Thus, the

peak hold portion 4 detects the color level of the

5   background of the original image, and provides the

thus-detected level to the A-D converting portion 3 as

the reference voltage. Thereby, the influence of the

color of the background of the original image on the

image signal outputted from the A-D converting portion

10   3 is eliminated.

The peak value of the image signal varies

due to variation in the color of the background of the

original image. In many cases, the original image

read by the image reading apparatus is an image

15   printed on a paper sheet. In such a case, the above-

mentioned color of the background of the original

image is the color of this paper sheet. The color of

the paper sheet on which the original image was

printed is ordinarily white. However, there is a case

20   where the color of the paper sheet on which the

original image was printed is not white, but is red,

for example. Therefore, the peak value of the image

signal varies as the color of the paper sheet on which

the original image was printed varies. As a result,

25   the output of the peak hold portion 4 varies, and,

1 accordingly, the reference voltage of the A-D

converting portion 3 varies. Thereby, the output from

the A-D converting portion 3 varies. As a result, the

level of the black offset which should be eliminated

5 from the image signal through the black shading

correction performed by the black shading correction

portion 5 varies. Therefore, the black shading

correction to eliminate the black offset from the

image signal performed by the black shading portion 5

10 should be performed at the same time (in real time)

the image signal obtained when the background of the

original image is read is processed.

However, the number of the photoelectric

sensors of the CCD which can be used as the OPB

15 portion is limited, because almost all of the

photoelectric sensors are used for reading the

original image and the photoelectric sensors used as

the OPB portion cannot be used for reading the

original image. Therefore, when the signal-to-noise

20 ratio (S/N ratio) of the image reading apparatus is

bad, variation in the average of the outputs of the

photoelectric sensors of the OPB portion occurs due to

the noise. Thereby, the black reference level used

for the black shading correction may vary for each

25 line due to the noise. When the black reference level

1 varies for each line due to the noise, the following
situation occurs: Although the black offset level of
the original image does not vary or varies smoothly in
the sub-scan direction, a pattern of lateral stripes
5 develops in the image represented by the image signal,
because the black reference level used for the black
shading correction varies for each line due to the
noise, and, thereby, the level of the image signal
obtained through the black shading correction varies
10 for each line.

SUMMARY OF THE INVENTION

The present invention has been devised in
order to solve the above-described problem, and an
15 object of the present invention is to provide an image
reading apparatus by which the black shading
correction to eliminate the black offset can be
performed at the same time (in real time) the image
signal obtained when the background level of the
20 original image is read is processed, and, also,
variation in the average of outputs of the OPB portion
for each line can be controlled.

An image reading apparatus, according to the
present invention, comprises:
25 photoelectrically converting means for

1   photoelectrically converting image information

obtained from optically reading an original image,

line by line, and outputting an image signal, the

photoelectrically converting means having optically

5   shielding means provided at a portion thereof; and

black shading correction means for

correcting the image signal using a black reference

level, the black reference level being obtained from

the portion of the photoelectrically converting means

10   for each line during an operation of the reading of

the original image,

wherein the black reference level used by

the black shading correction means for each line is

obtained using black reference values, each of the

15   black reference values being data of the portion of

the photoelectrically converting means for a

respective one of a plurality of lines.

In this arrangement, the black reference

level used by said black shading correction means for

20   each line is obtained using black reference values,

each of the black reference values being data of the

portion of the photoelectrically converting means for

a respective one of a plurality of lines. Thereby, it

is possible to control the variation in the level of

25   the image signal for each line due to the variation in

1   the black reference level used by the black shading

correction means for each line due to noise.

The black reference level may be a weighted

average of the black reference values.

5   Thereby, it is possible to control the

variation in the level of the image signal for each

line due to the variation in the black reference level

used by the black shading correction means for each

line due to noise, and, also, it is possible to enable

10   the correction performed by the black shading

correction means to well follow the variation in the

black offset level of the image signal due to

variation in the level of the image signal, for each

line, by appropriately selecting the above-mentioned

15   plurality of lines and appropriately determining the

coefficient of the weighted-averaging.

The black reference value for a respective

line may be an average of pixel values in a main scan

direction, and the weighted average of the black

20   reference values is obtained from weighted-averaging,

in a sub-scan direction, the black reference values.

The black reference level for each line may

be obtained from weighted-averaging the black

reference value for the current line and the black

25   reference level for the preceding line.

1   In this arrangement, it is possible to
enable the correction performed by the black shading
correction means to well follow the variation in the
black offset level of the image signal due to

5   variation in the level of the image signal, for each
line, and, also, it is possible to reduce the size of
the arrangement of the black shading correction means.
The black reference level may be a moving
average of the black reference values.

10   In this arrangement, it is possible to
simplify the arrangement of the black shading
correction means.
The black reference value for a respective
line may be an average of pixel values in a main scan

15   direction, the moving average being obtained from
moving-averaging, in a sub-scan direction, the black
reference values.
The black reference level for each line may
be obtained from moving-averaging the black reference

20   values for the plurality of lines.
The plurality of lines may comprise the
current line and preceding lines.
In this arrangement, it is possible to
enable the correction performed by the black shading

25   correction means to well follow the variation in the

1　　black offset level of the image signal due to

variation in the level of the image signal, for each

line.

　　　Other objects and further features of the

5　　present invention will become more apparent from the

following detailed description when read in

conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10　　　　FIG. 1 shows an arrangement of photoelectric

sensors of a CCD used for reading an original image in

an image reading apparatus in each of the related art,

and first and second embodiments of the present

invention;

15　　　　FIG. 2 is a block diagram showing essential

portions of an image reading apparatus in the related

art;

　　　　FIG. 3 is a block diagram showing essential

portions of an image reading apparatus in the first

20　　embodiment of the present invention;

　　　　FIG. 4 is a block diagram showing an

internal arrangement of a black shading correction

portion shown in FIG. 3;

　　　　FIG. 5 is a block diagram showing essential

25　　portions of an image reading apparatus in the second

1   embodiment of the present invention; and

     FIG. 6 is a block diagram showing an

internal arrangement of a black shading correction

portion shown in FIG. 5.

5

     DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

     Embodiments of the present invention will

now be described.

     FIG. 3 is a block diagram showing essential

10   portions of an image reading apparatus, in a first

embodiment of the present invention, including a black

shading correction portion, which performs the black

shading correction.

     As shown in FIG. 3, the image reading

15   apparatus in the first embodiment includes a CCD

portion 1 which comprises a CCD including a line of

photoelectric sensors extending in the main scan

direction, and generates an image signal as a result

of reading an original image. The reading of the

20   original image is performed as follows: The CCD

portion 1 scans a first line of the original image in

the main scan direction along the line of the

photoelectric sensors of the CCD (whereby image data

of a first line is obtained) and scans the original

25   image in the sub-scan direction (perpendicular to the

1   main scan direction) by sequentially scanning
subsequent lines of the original image (whereby image
data of respective lines, i.e., a second line, a third
line, ..., an n-th line, is obtained in sequence).

5   The CCD of the CCD portion 1 is the same as the above-
described CCD having the OPB portion. The image
reading apparatus further includes a signal processing
portion 2 which performs processing of an analog image
signal outputted from the CCD portion 1, an A-D

10   converting portion 3 which is an A-D converter
converting the analog image signal into a digital
image signal, a peak hold (P/H) portion 4 for
detecting a background level of the original image, a
black shading correction portion 15 which performs a

15   black shading correction, using the data of the black
reference level, on the image signal, and a white
shading correction portion 6 which performs a white
shading correction on the image signal.

       The arrangement of the image reading

20   apparatus in the first embodiment is the same as the
image reading apparatus in the related art shown in
FIG. 2, except for the black shading correction
portion 15. That is, each of the portions 1, 2, 3, 4
and 6 of the image reading apparatus in the first

25   embodiment is the same as a respective one of the

1   portions 1, 2, 3, 4 and 6 in the related art shown in
FIG. 2.

The black shading correction portion 15
includes an average calculating circuit 17 which

5   calculates the average of outputs of the CCD portion 1
during the period during which the CCD portion 1
outputs data obtained through the photoelectric
sensors of the above-mentioned OPB portion of the CCD,
a weighted-average circuit 19 which performs weighted-

10   averaging using values outputted from the average
calculating circuit 17, and a subtracter 18 which
subtracts the value calculated by the weighted-average
circuit 19 from the data of the image signal outputted
from the A-D converting circuit 3.

15   In FIG. 3, the analog image signal outputted
by the CCD portion 1 undergoes signal processing
through the signal processing portion 2, and, then, is
converted into the digital image signal by the A-D
converting portion 3. The digital image signal

20   outputted from the A-D converting portion 3 is
inputted to the black shading correction portion 15,
undergoes the black shading correction therethrough,
and, then, is outputted. The image signal outputted
from the black shading correction portion 15 is

25   inputted to the white shading correction portion 6.

1   The white shading correction portion 6 performs the
    white shading correction of the data of the thus-
    inputted image signal using white reference data which
    was obtained using a white reference plate or the
5   like. Then, the image signal is inputted to an image
    processing block (not shown in the figure).

    The average calculating circuit 17 of the
    black shading correction portion 15 obtains outputs of
    the OPB portion of the CCD portion 1 (from the CCD
10 portion 1 via the signal processing portion 2 and A-D
    converting portion 3) before the CCD portion 1 reads
    the original image, for each line. Then, the average
    calculating circuit 17 calculates the average of these
    outputs, and outputs the average as Dopb. The
15 weighted-average circuit 19, which receives the
    average Dopb, calculates a weighted average Db,n (data
    of a black reference level) using the average Dopb,
    and outputs the calculated weighted average Db,n to
    the subtracter 18. The weighted average Db,n results
20 from a weighted-average calculation being repeated for
    each line from the second line to the current line,
    the weighted-average calculation using the average
    Dopb,1 for the first line through the average Dopb,n
    for the current line. The subtracter 18, which has
25 received the weighted average Db,n, subtracts the

1   weighted average Db,n from the data DO of the image

signal (outputted from the A-D converting portion 3

when the original image is read), and outputs the

thus-obtained data to the white shading correction

5   portion 6. The calculation of the average performed

by the average calculating circuit 17 is performed

only during the period during which the average

calculating circuit 17 receives the OPBGATE signal,

which is provided to the average calculating circuit

10   17 only during the period during which the data

obtained from the OPB portion of the CCD portion 1 is

outputted from the CCD portion 1.

Further, in the arrangement of the first

embodiment shown in FIG. 3, as in the related art

15   shown in FIG. 2, the peak hold (P/H) portion 4 is

connected between the signal processing portion 2 and

the A-D converting portion 3. The peak hold portion 4

holds the peak value of the output from the signal

processing portion 2, and provides the peak value to

20   the A-D converting portion 3 as the reference voltage

of the A-D converting portion 3. Because the

operation of the peak hold circuit 4 in the first

embodiment is the same as the operation of the peak

hold circuit 4 in the related art shown in FIG. 2,

25   further description is omitted.

1   As described above, in the black shading
correction portion 15 in the first embodiment, the
data of the black reference level for eliminating the
black offset from the image signal is obtained as a
5   result of performing weighted-averaging using the
average of the data obtained from the data outputted
from the OPB portion of the CCD of the CCD portion 1
for the first line through the average of the data
obtained from the data outputted from the OPB portion
10   of the CCD of the CCD portion for the current line in
sequence. In this case, the weighted average Db,n is
obtained from the following equation (1), for example:

Db,n = Dopb,n / A + Db,n-1 X (A-1) / A

15   ... (1)

where:
'Db,n' represents the data of the black
reference level (which is subtracted from the data DO
of the image signal through the subtracter 18) for the
20   n-th line;
'Db,n-1' represents the data of the black
reference level (which is subtracted from the data DO
of the image signal through the subtracter 18) for the
(n-1)-th line;
25   'Dopb,n' represents the average or a

1   weighted average of the data obtained from the data

outputted from the OPB portion for the n-th line (that

is, the average or a weighted average of the data of

the image signal outputted from the A-D converting

5   portion 3 during the period during which the data

obtained from the OPB portion of the CCD portion 1 is

outputted from the CCD portion 1 before the original

image is read for the n-th line); and

'A' represents a constant (weighted-average

10   coefficient)..

However, when the image data for the first

line is processed, that is, when n = 1,

$$D_{b,1} = D_{opb,1}$$

15

Assuming that the S/N ratio of the image

reading apparatus is bad, and, thereby, the average

$D_{opb,n}$ of the data obtained from the data outputted

from the OPB portion for each line varies, the average

20   $D_{opb,n}$ is expressed as follows:

$$D_{opb,n} = D_{b,n-1} + \alpha \qquad \cdots \ (2)$$

where α represents the variation due to the

25   noise.

1   As a result of substitution of the equation

(2) in the equation (1), the following equation (3) is

obtained:

5      $D_{b,n} = D_{b,n-1} + \alpha / A$ $\cdots$ (3)

From the equation (3), it can be seen that,

by performing the weighted-averaging as in the first

embodiment of the present invention, the variation α

10   due to the noise is reduced by a factor of A.

FIG. 4 is a block diagram showing the

internal arrangement of the weighted-average circuit

19.

The weighted-average circuit 19 includes a

15   multiplier 21 which multiplies the weighted average

$D_{b,n-1}$ for the preceding line, outputted from the

weighted-average circuit 19, by (A - 1), an adder 20

which adds the value outputted from the multiplier 21

to the average $D_{opb,n}$, provided by the average

20   calculating circuit 17, and a divider 22 which divides

the value outputted from the adder 20 by A so as to

output the weighted average $D_{b,n}$ (the data of the

black reference level which is subtracted from the

data D0 of the image signal through the subtracter

25   18). However, when the image data for the first line

1   is processed, that is, when n = 1, the weighted-

average circuit 19 outputs the inputted average

$D_{opb,1}$, as it is, as the data $D_{b,1}$ of the black

reference level (which is subtracted from the data D_O

5   of the image signal through the subtracter 18) for the

first line.

     In the arrangement shown by the block

diagrams of FIGS. 3 and 4, the value obtained as a

result of weighted-averaging shown in the above-

10   mentioned equation (1) being performed is outputted to

the subtracter 18. Accordingly, as shown in the

above-mentioned equation (3), it is possible to reduce

the variation due to the noise by the factor of A.

     Thus, by using the weighted-average circuit

15   19, it is possible to take measures to deal with the

situation that the S/N ratio of the image reading

apparatus is bad, using the very simple arrangement at

a low cost.

     Further, as a feature of the weighted-

20   average circuit, as shown in the above-mentioned

equation (1), the data $D_{b,n}$ of the black reference

level for the current line is affected by the average

$D_{opb,n}$ for the current line most greatly. Thereby, by

using the weighted-average circuit, it is possible

25   that the black shading correction well follows the

1   variation in the black offset level.

In a case where the above-described
weighted-average circuit 19 is formed by hardware, the
calculation can be performed only by shifting of the
5   register values when the constant A used in the above-
mentioned equation (1) is determined to be a power of
two (for example, 2, 4, 8 or the like). Thereby, it
is possible to simplify the arrangement of the
hardware.
10   Instead of performing the weighted-average
calculation as in the first embodiment, it is also
possible to perform a moving-average calculation using
the average Dopb,n-m for the (n − m)-th line (m-th
previous line) through the average Dopb,n for the n-th
15   line (current line). Also in this case, it is
possible to reduce the influence due to a bad S/N
ratio of the image reading apparatus on the black
reference level used for the black shading correction.

FIG. 5 is a block diagram showing essential
20   portions of an image reading apparatus, in a second
embodiment of the present invention, including a black
shading correction portion, which performs the black
shading correction using the data of the black
reference level obtained as a result of performing the
25   above-mentioned moving-average calculation.

1   As shown in FIG. 5, the image reading
apparatus in the second embodiment includes a CCD
portion 1 which comprises a CCD including a line of
photoelectric sensors extending in the main scan

5   direction, and generates an image signal as a result
of reading an original image. The reading of the
original image is performed as follows: The CCD
portion 1 scans a first line of the original image in
the main scan direction along the line of the

10   photoelectric sensors of the CCD (whereby image data
of the first line is obtained) and scans the original
image in the sub-scan direction (perpendicular to the
main scan direction) by sequentially scanning
subsequent lines of the original image (whereby image

15   data of respective lines, i.e., a second line, a third
line, ..., an n-th line, is obtained in sequence).
The CCD of the CCD portion 1 is the same as the above-
described CCD having the OPB portion. The image
reading apparatus further includes a signal processing

20   portion 2 which performs processing of an analog image
signal outputted from the CCD portion 1, an A-D
converting portion 3 which is an A-D converter
converting the analog image signal into a digital
image signal, a peak hold (P/H) portion 4 for

25   detecting the background level of the original image,

1   a black shading correction portion 25 which performs a

black shading correction, using the data of the black

reference level, on the image signal, and a white

shading correction portion 6 which performs a white

5   shading correction on the image signal.

The arrangement of the image reading

apparatus in the second embodiment is the same as the

image reading apparatus in the first embodiment shown

in FIG. 3, except for the black shading correction

10   portion 25. That is, each of the portions 1, 2, 3, 4

and 6 of the image reading apparatus in the second

embodiment is the same as a respective one of the

portions 1, 2, 3, 4 and 6 in the first embodiment

shown in FIG. 3.

15   The black shading correction portion 25

includes an average calculating circuit 17 which

calculates the average Dopb of the outputs of the CCD

portion 1 (obtained via the signal processing portion

2 and A-D converting portion 3) during the period

20   during which the CCD portion 1 obtains data through

the photoelectric sensors of the above-mentioned OPB

portion of the CCD, a moving-average circuit 29 which

performs moving-averaging using values outputted from

the average calculating circuit 17, and a subtracter

25   18 which subtracts the moving average Db thus

1   calculated by the moving-average circuit 19 from the

data D0 of the image signal outputted from the A-D

converting circuit 3 when the original image is read.

In FIG. 5, the analog image signal outputted

5   by the CCD portion 1 undergoes signal processing by

the signal processing portion 2, and, then, is

converted into the digital image signal by the A-D

converting portion 3. The digital image signal

outputted from the A-D converting portion 3 is

10   inputted to the black shading correction portion 25,

undergoes the black shading correction therethrough,

and, then, is outputted. The image signal outputted

from the black shading correction portion 25 is

inputted to the white shading correction portion 6.

15   The white shading correction portion 6 performs the

white shading correction of the data of the thus-

inputted image signal using the white reference data

which was obtained using a white reference plate or

the like. Then, the image signal is inputted to an

20   image processing block (not shown in the figure).

The average calculating circuit 17 of the

black shading correction portion 25 calculates the

average of outputs of the OPB portion of the CCD

portion 1 (obtained from the CCD portion 1 via the

25   signal processing portion 2 and A-D converting portion

1   3) before the CCD portion 1 reads the original image,

for each line.   Then, the average calculating circuit

17 outputs the thus-calculated average Dopb.   The

moving-average circuit 29, which receives the average

5   Dopb, calculates a moving average Db,n (the average,

in the sub-scan direction, of (m + 1) averages, each

of which averages is the average in the main scan

direction) and outputs the moving average Db,n to the

subtracter 18.   The moving average Db,n is obtained as

10   a result of a moving-average calculation being

performed using the average Dopb,n-m for the (n - m)-

th line (m-th previous line) through the average

Dopb,n for the n-th line (current line).   The

subtracter 18, which has received the moving average

15   Db,n, subtracts the moving average Db,n from the data

DO of the image signal outputted from the A-D

converting portion 3 when the original image is read,

and outputs the thus-obtained data to the white

shading correction portion 6.   The calculation of the

20   average performed by the average calculating circuit

17 is performed only during the period during which

the average calculating circuit 17 receives the

OPBGATE signal which is provided to the average

calculating circuit 17 only during the period during

25   which the data obtained from the OPB portion of the

1   CCD portion 1 is outputted from the CCD portion 1.

Further, in the arrangement of the second

embodiment shown in FIG. 5, as in the first embodiment

shown in FIG. 3, the peak hold (P/H) portion 4 is

5   connected between the signal processing portion 2 and

the A-D converting portion 3. The peak hold portion 4

holds the peak value of the output from the signal

processing portion 2, and provides the peak value to

the A-D converting portion 3 as the reference voltage

10   of the A-D converting portion 3. Because the

operation of the peak hold circuit 4 in the second

embodiment is the same as the operation of the peak

hold circuit 4 in the first embodiment shown in FIG.

3, further description is omitted.

15   As described above, in the black shading

correction portion 25 in the second embodiment, the

data of the black reference level for eliminating the

black offset from the image signal is obtained as a

result of performing moving-averaging using the

20   average of the data obtained from the data outputted

from the OPB portion of the CCD of the CCD portion 1

for the (n - m)-th line (m-th previous line) through

the average of the data obtained from the data

outputted from the OPB portion of the CCD of the CCD

25   portion 1 for the n-th line (current line). In this

1   case, the moving average Db,n is obtained from the

following equation (4), for example:

Db,n = ΣDopb,x (n - m, n) / (m + 1) $\cdots$

5   (4)

where:

'Db,n' represents the value of the black

reference level (which is subtracted from the data D0

10   of the image signal through the subtracter 18) for the

n-th line;

'ΣDopb,x (n - m, n)' represents the sum of

the Dopb,x for x = n - m through n, that is, the sum

of Dopb,n-m through Dopb,n; and

15   'Dopb,x' represents the average or a

weighted average of the data obtained from the data

outputted from the OPB portion for the x-th line (that

is, the average or a weighted average of the data of

the image signal outputted from the A-D converting

20   portion 3 during the period during which the data

obtained from the OPB portion of the CCD portion 1 is

outputted from the CCD portion 1 before the original

image is read for the x-th line).

However, when 1 < n ≤ m,

25

1       $D_{b,n} = \Sigma D_{opb,x} (1, n) / n$

      where $'\Sigma D_{opb,x} (1, n)'$ represents the sum of

the $D_{opb,x}$ for $x = 1$ through n, that is, the sum of

5    $D_{opb,1}$ through $D_{opb,n}$.

      When $n = 1$,

      $D_{b,1} = D_{opb,1}$

10   FIG. 6 is a block diagram showing the

internal arrangement of the moving-average circuit 29.

      As shown in FIG. 6, the moving-average

circuit 29 includes a latch circuit 30 which latches

the average $D_{opb,n-m}$ for the $(n - m)$-th line through

15   the average $D_{opb,n-1}$ for the $(n - 1)$-th line, which

were already outputted from the average calculating

circuit 17 in sequence, and outputs the thus-latched

values in parallel. The moving-average circuit 29

further includes an average calculating circuit 31

20   which calculates the sum of the average $D_{opb,n}$ for the

n-th line (current line), outputted from the average

calculating circuit 17 and the average $D_{opb,n-m}$ for

the $(n - m)$-th line through the average $D_{opb,n-1}$ for

the $(n - 1)$-th line, outputted from the latch circuit

25   30. Then, the average calculating circuit 30 divides

1   the thus-obtained sum by (m + 1), that is, by the

total number of the averages Dopb,n-m through Dopb,n

inputted to the average calculating circuit 30.

However, when $1 < n \leq m$, the latch circuit

5   30 latches the average Dopb,1 for the first line

through the average Dopb,n-1 for the (n - 1)-th line,

already outputted from the average calculating circuit

17 in sequence, and outputs the thus-latched values in

parallel. The average calculating circuit 31

10   calculates the sum of the average Dopb,n for the n-th

line (current line), outputted from the average

calculating circuit 17 and the average Dopb,1 for the

first line through the average Dopb,n-1 for the (n -

1)-th line, outputted from the latch circuit 30.

15   Then, the average calculating circuit 30 divides the

thus-obtained sum by n, that is, by the total number

of the averages Dopb,1 through Dopb,n inputted to the

average calculating circuit 30.

When n = 1, the moving-average portion 29

20   outputs the inputted average Dopb,1, as it is, as the

black reference value Db,1.

When comparing the first embodiment, shown

in FIGS. 3 and 4, with the second embodiment, shown in

FIGS. 5 and 6, the first embodiment is superior for

25   the following reasons.

1   In the second embodiment, it is necessary to
increase the number $(m + 1)$ of the averages $Dopb,n-m$
through $Dopb,n$ (the average Db,n of which averages is
used as the data of the black reference level to be
5   subtracted from the data DO of the image signal in the
black shading correction), in order to increase the
accuracy of the data of the black reference level used
for the black shading correction, that is, in order to
increase the accuracy of the value Db,n to be
10   subtracted from the data DO of the image signal so as
to eliminate the black offset from the image signal.
For this purpose, a large number of registers are
needed, and, as a result, the size of the entire
circuit increases. Further, in this case, because the
15   number $(m + 1)$ of the averages $Dopb,n-m$ through $Dopb,n$
(the average Db,n of which averages is used as the
data of the black reference level) increases, it is
not possible that the black shading correction well
follows the variation in the black offset level.
20   In order to enable the black shading
correction to well follow the variation in the black
offset level, it is necessary to reduce the number $(m + 1)$ of the averages $Dopb,n-m$ through $Dopb,n$ (the
average Db,n of which averages is used as the data of
25   the black reference level). However, in this case,

1 the accuracy of the data of the black reference level

decreases. Thereby, it is not possible to

sufficiently reduce the influence due to a bad S/N

ratio of the image reading apparatus on the data of

5 the black reference level used for the black shading

correction. For example, it is merely possible to

reduce the variation due to the noise by a factor of 2

or 3, although it is possible to reduce the variation

due to the noise by the factor of A in the first

10 embodiment as shown in the above-mentioned equation

(3), where the constant A can be adjusted

appropriately.

 Thus, although the arrangement, such as that

in the second embodiment, in which the data of the

15 black reference level is obtained through the moving-

averaging in the sub-scan direction of the averages,

each being the average of the pixel values of the OPB

portion in the main scan direction, is possible, the

arrangement, such as that in the first embodiment, in

20 which the black reference level is obtained through

the weighted-averaging in the sub-scan direction of

the averages, each being the average of the pixel

values of the OPB portion in the main scan direction,

is superior.

25 Thus, as a result of the weighted-average or

1   the moving-average of values, each of the values being

data of the shielded portion (OPB portion) of the

photoelectric device for a respective line, being used

as the data of the black reference level used for the

5   black shading correction, it is possible to control

the variation in the level of the image signal for

each line due to the variation in the black reference

level used for the black shading correction for each

line due to noise, and, also, it is possible to enable

10   the black shading correction to well follow the

variation in the black offset level of the image

signal due to variation in the level of the image

signal, for each line.

The present invention is not limited to the

15   above-described embodiments, and variations and

modifications may be made without departing from the

scope of the present invention.

The present invention is based on Japanese

priority application No. 10-296061 filed on October 2,

20   1998, the entire contents of which are hereby

incorporated by reference.

25